REMARKS

Examiner Berezny is thanked for his examination of the subject Patent Application. The Specification and Claims have been carefully reviewed with respect to the cited prior art, the Claims are considered to be in condition for Allowance.

The Examiner writes:

1. The amendment filed 6/10/03 under 37 CFR 1.116 in reply to the final rejection has been considered but is not deemed to place the application in condition for allowance and will not be entered because it raises new issues and/or requires the examiner to conduct an additional search.

The Applicant responds:

The Applicant has further amended the claims in view of this Advisory Action and they are now in condition for allowance.

The Examiner writes:

2. Applicant's proposed amendment would overcome the examiner's 112 rejection of claims 8 and 25.

3. Applicant's attention is directed to claim 13, where arguments are made referring to changes that are found neither in the clean copy nor the marked-up copy.

The Applicant responds:

The previously amended version of claim 13 was inadvertently omitted when the claims listing was created. Claim 13 now appears in the claims listing as further amended in view of this Advisory Action.

Response to Arguments

The Examiner writes:

4. Applicant's arguments filed 6/10/03 have been fully considered but they are not persuasive. On page 11 of the response, applicant asserts that Zhou fails to teach the formation of Si02 in forming a protection layer. Applicant's attention is directed to col.8,

ln. 5-20, which further elaborat s on the reaction ch mistry. Note that the sulfur containing gases consist of SO2 and SO3 and further include oxygen gas: During the sulfating and sulfonating reactions the oxygen will react with any available silicon atoms, thus form SiO2 as claimed. The net result is that the sulfur-containing layer inherently also contains silicon dioxide. Applicant also argues that there are no silicon atoms present in the Zhou structure. Applicant's attention is directed to col.4, ln.24-46, which teaches the use of hydrogen-doped and carbon-doped silicon dioxide. Both hydrogen and carbon doping inherently contain silicon-hydrogen and silicon-carbon bonds, which would be broken in the presence of oxygen, forming silicon dioxide and by-products of water and carbon dioxide. Further, the formation of silicon dioxide by the prior art provides the claimed structure and function claimed, even if not explicitly .expressed in the reference.

The Applicant responds:

The Examiner may have a point in suggesting that:

$$SiO2 + O2 > SiO2$$
$$H\text{-}Si + O2 > SiO2 + H2O, \text{ etc.}$$

However, the source of silicon in the porous silicon oxide is so sparse that any chemical combination would not produce a sufficiently thick or impervious layer to prevent outgassing of moisture found in the porous insulative layers. Zhou does not discuss what the Examiner suggests. Zhou does not discuss SiO2 and it's outgassing preventive qualities. Zhou speaks only to a sulfur-containing sidewall passivation layer 82.

The Examiner writes:

5. Applicant argues that Zhou performs applicant's two steps simultaneously, but applicant's claims fail to require separate steps. A simultaneous step is within the scope of the claims. Further, applicant's assertion of a relevant amendment to claim 13, is unsupported.

The Applicant responds:

Claim 13 has been further amended with wording that requires the photoresist be removed from the second insulative layer and the low-k protective layer applied to the second insulative layer. With this word construction, it is not possible to simultaneously do both on the same surface. Thes steps must

inherently be separate.

The Examiner writ s:

> 6. Applicant also argues that Zhou teaches two protective coatings, while applicant teaches just one. Applicant's claims use the term "comprising", which broadens the scope of applicant's claims to include extra steps and layers. Further, it is still possible to form the claimed barrier layer in the vias and trenches, even with the use of resist.

The Applicant responds:

Claims 1 and 13 have been amended to require the forming of respective layers "on" not "over" respective previously formed layers. In this wording it is not possible to have two protective or two barrier layers between the porous insulating layer and the inlaid metal.

The Examiner writes:

> 7. Applicant asserts that Lin teaches a barrier layer 100 to 2000 angstroms, while the claimed invention only claims 30-500 angstroms. The ranges overlap and therefore the claimed invention infringes on Lin.

The Applicant responds:

Claims 11 and 29 are dependent on claims 1 and 13 respectively.

The Examiner writes:

> 8. Applicant attacks the Lin reference asserting that Lin does not teach the etching of low-K dielectrics, but rather silicon oxide and nitride. Applicant further asserts that the claimed recipe "would be of no use to Lin". Applicant's attention is directed to applicant's claim 19 and 24, which teach applicant's claimed recipe is used to etch an etch stop layer, which is claimed to consist of silicon nitride. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See In re Keller, 642 F .2d 413,208 USPQ 871 (CCPA 1981); In re Merck & Co., 800 F.2d 1091,231 USPQ 375 (Fed. Giro 1986).

Respectfully, the Applicant does not "attack" this reference individually. The Applicant quite clearly states that Lin does not provide the same gas components and recipe for the service needed, namely etching low-k materials. This is not an "attack" but a statement of fact of where Lin does not fit into the

combination of references of which the Examiner opines.

Furthermore, Since Lin is not etching low-k dielectrics, h would not be interested in recipes that etch low-k dielectrics. Similarly, since the Applicants are etching low-k dielectrics, they are not interested in recipes that etch SiN_2.

The fact that the instant invention has an etch-stop layer of SiN_2 or other material to etch, as the Examiner has noticed, is not the major issue, and diverts the attention from that of etching low-k materials.

The Examiner continues:

> Applicant's assert that Lin does not teach the claimed gas components because Lin does. not etch low-k materials. Such reasoning is flawed and incorrect because it uses allegedly different applications of the etch gases to deny the existence of the etch gases. Furthermore, applicant's attention is directed to the fact that porous oxides and nitrides are considered to be low-k dielectrics. Therefore, It would have been obvious to one of ordinary skill in the art at the time of the invention to use the same etch chemistry to etch oxides and nitrides, as to etch porous oxides and porous nitrides.

The Applicant responds:

The Applicant respectfully denies the Examiner's suggestion of a flawed and incorrect reasoning. The Applicant comes from the point of view that Lin is presenting a particular gas combination that Lin finds successful in etching a (non-porous) silicon oxide layer to form a particular shape. That particular gas combination of Lin is as stated:

> To achieve the required selective etch reaction, a plasma **made up** of CHF3 (or CF4) **plus** oxygen was used.

The word "**made up**" in The American Heritage Dictionary means:

> "1. Fabricated; fictitious; imaginary; invented; 2. Changed or adorned by the application of cosmetics or make-up; 3a. Complete; finished; b. **Put together**; **assembled**; arranged."

It does **not** mean "comprise".

The word "**plus**" means "added or extra".

In Lin's teaching, Lin is specific about the gases for his needs and does not anticipate using Argon or Nitrogen let alone specify other CF or CHF gases.

The Applicant is aware of etch chemistries in general and has found a particular gas combination, other than that used by Lin, that is effective in the etching of low-k insulative layers.

The Examiner writes:

> 9. Applicant asserts that the instant application predates Eissa, which is incorrect because Eissa has priority back to Nov. 20, 2000. Finally, applicant asserts that Eissa teaches the use of commercial low-k dielectric products, which are well known in the art, thus not teaching anything new. The cited art is used in the rejection to merely assert that the use of a low-k dielectric with a value between 2 and 3, is known and would be obvious. Applicant's arguments seem to be confirming the examiner's assertion.

The Applicant responds:

Claims 6 and 17 are respectively dependent on claims 1 and 13.

CONCLUSION

It is respectfully suggested that these various references cannot be combined without reference to applicants' own invention. It is believed that independent claims 1 and 13, and hence claims dependent from claim 1, and claims dependent from claim 13, as amended, are allowable, and we therefore request respectfully that Examiner Berezy reconsider these rejections in view of these arguments and the amendments and allow claims 1 through 30

We have reviewed the related art references made of record and agree with the Examiner that none of these suggest the present claimed invention.

In light of the above arguments, it is suggested that th specification now

adequately describes the invention and that the Claims now clearly distinguish the invention from the prior art. All claims are therefore believed to be in condition for allowance.

Allowance of all claims is therefore respectfully requested.

It is request that should Examiner Berenzy not find that the Claims are now Allowable that the Examiner call the undersigned attorney at 845-452-5863 to overcome any problems preventing allowance.

Respectfully submitted,

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IN THE CLAIMS

1. (CURRENTLY AMENDED) A method to solve via poisoning for insulative porous low-k materials comprising the steps of:

providing a substrate having a first and a second insulative layers separated from each other by an intervening etch-stop layer formed therein said substrate;

forming a hole opening in said first and second insulative layers, including said intervening etch-stop layer;

forming a low-k protection layer over said ~~substrate~~ second insulating layer, including in said hole opening, wherein said low-k protection layer prevents outgassing from said first and second insulative layers;

forming a trench opening over said hole opening to form a dual damascene structure;

forming a barrier layer on the vertical walls of said trench opening and on said low-k protection layer on the vertical walls of said hole opening;

forming a metal layer ~~over~~ on said barrier layer in said dual damascene structure; and

performing chemical mechanical polishing (CMP), to complete the forming of said dual damascene structure.

2. (ORIGINAL) The method of claim 1, wherein said first insulative layer is a low-k dielectric having a dielectric constant between about 2.0 to 3.0.

3. (ORIGINAL) The method of claim 1, wherein said first insulative layer has a thickness between about 2000 to 100000 Å.

4. (ORIGINAL) The method of claim 1, wherein said intervening etch-stop layer is silicon nitride.

5. (ORIGINAL) The method of claim I, wherein said intervening etch-stop layer has a thickness between about 50 to 1000 Å.

6. (ORIGINAL) The method of claim I, wherein said second insulative layer is a low-k dielectric having a dielectric constant between about 2.0 to 3.0.

7. (ORIGINAL) The method of claim 1, wherein said second insulative layer has a thickness between about 2000 to 100000 Å.

8. (CURRENTLY AMENDED) The method of claim 1, wherein, said low-k protection layer material is selected from the group comprising ~~comprises~~ SiO_2, SiN, SiC or SiNC.

9. (ORIGINAL) The method of claim 1, wherein said low-k protection layer has a thickness between about 20 to 1000 Å.

10. (CURRENTLY AMENDED) The method of claim 1, wherein said barrier layer material is selected from the group comprising ~~comprises~~ Ta, Ti, TaN, TiSiN, TaSiN, or WN.

11. (ORIGINAL) The method of claim 1, wherein said barrier layer has a thickness between about 30 to 500 Å.

12. (ORIGINAL) The method of claim 1, wherein said metal comprises copper.

13. (CURRENTLY AMENDED) A method to solve via poisoning for insulative porous low-k materials in a dual damascene structure comprising the steps of:

providing a substrate having a passivation layer formed over a first metal layer formed on said substrate;

forming a first insulativ layer over said substrate;

forming an etch-stop layer over said first insulative layer;

forming a second insulative layer over said etch-stop layer;

forming a first photoresist layer over said second insulative layer and patterning said photoresist to form a first photoresist mask having a hole pattern;

etching said first and second insulative layers, including said etch-stop layer through said hole pattern to form a hole reaching said passivation layer;

removing said first photoresist mask from said second insulative layer;

forming a low-k protection layer over said substrate on said second insulative layer , including in said hole opening;

forming a second photoresist layer over said substrate, including said hole opening and patterning said second photoresist to form a second photoresist mask having a trench pattern; .

etching said second insulative layer through said trench pattern in said second photoresist mask to form a trench in said second insulative layer, thus

completing the forming of said dual damascene structure in said substrate;

removing said second photoresist mask;

removing said low-k protection layer from over said substrate and from the bottom of said hole opening and thereby exposing underlying said passivation layer while leaving said low-k protection layer on the vertical sides of said hole opening;

removing said passivation layer from said bottom of said hole opening, thereby exposing underlying said first metal layer;

forming a barrier layer over said substrate, including in said dual damascene structure, wherein said barrier layer conforms to said low-k protective layer in said hole opening and conforms to said trench in said second insulative layer;

depositing a second metal over said barrier layer in said dual damascene structure; and

performing chemical mechanical polishing (CMP) to complete the forming of said dual damascene structure.

14. (ORIGINAL) The method of claim 13, wherein said substrate is silicon.

15. (ORIGINAL) Th method of claim 13, wh rein said passivation layer comprises silicon nitride (SiN).

16. (ORIGINAL) The method of claim 13, wherein said passivation layer has a thickness between about 30 to 1000 Å.

17. (ORIGINAL) The method of claim 13, wherein said first insulative layer is a low-k dielectric having a dielectric constant between about 2.0 to 3.0.

18. (ORIGINAL) The method of claim 13, wherein said first insulative layer has a thickness between about 2000 to 100000 Å.

19. (ORIGINAL) The method of claim 13, wherein said intervening etch-stop layer is silicon nitride.

20. (ORIGINAL) The method of claim 13, wherein said intervening etch-stop layer has a thickness between about 30 to 1000 Å.

21. (ORIGINAL) The method of claim 13, wherein said second insulative layer is a low-k dielectric having a dielectric constant between about 2.0 to 3.0.

22. (ORIGINAL) The method of claim 13, wherein said second insulative layer

has a thickness between about 2000 to 100000 Å.

23. (ORIGINAL) The method of claim 13, wherein said .etching said first and second insulative layers is accomplished with a recipe comprising C_2F_6, C_4F_3, Ar, N_2 and O_2.

24. (ORIGINAL) The method of claim 13, wherein said etching said etch-stop layer is accomplished with a recipe comprising C_2F_6, C_4F_3, Ar, N_2 and O_2

25. (CURRENTLY AMENDED) The method of claim 13, wherein said low-k protection layer material is selected from the group comprising ~~comprises~~ $Si0_2$, SiN, SiCN or SiC.

26. (ORIGINAL) The method of claim 13, wherein said low-k protection layer has a thickness between about 30 to 1000 Å.

27. (ORIGINAL) The method of claim 13, wherein said removing said low-k protection layer is accomplished with a recipe comprising C_2F_6, C_4F_3, Ar, N_2 and O_2.

28. (CURRENTLY AMENDED) The method of claim 13, wherein said barrier layer material is selected from the group comprising ~~comprises~~ Ta, Ti, TaN, TiSiN, TaSiN, or WN.

29. (ORIGINAL) The method of claim 13, wherein said barri r layer has a thickness between about 30 to 500 Å.

30. (ORIGINAL) The method of claim 13, wherein said second metal comprises copper.

31-33 (WITHDRAWN)